Space Weather Technical Forecast

Issued on Wednesday, 11 January 2023 at 12:07 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely. Chance of X-class flares (R3; Strong radio blackouts) throughout. A possible glancing blow from a CME later on the 12th January.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High over the past 24 hours, with an X1 flare observed at 10/2247 UTC, which originated from AR3186 near the northeast limb. Several M-class flares were also observed, the largest an M5.6 flare at 11/0156UTC from AR3184, in the southeast.

There are currently eight numbered sunspot regions on the visible disc. AR3182 in the southeast quadrant and AR3181 in the southwest remain the largest regions. Both of these regions continue to show slight overall decay. AR3184 located in the far SE quadrant has developed some minor trailing spots, with a Delta configuration now apparent in its intermediate portion. AR3186 in the far northeast continues to grow and develop, with a Delta configuration now apparent in its lead spot. AR3185 has developed further trailing spots. AR3180 and AR3183 appear little changed and relatively stable as they near the west limb. AR3187 has decayed to a single small spot.

No Earth-directed CMEs have been observed in available imagery in the period.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, started the period at slow-ambient levels but have drifted erratically above the slightly-elevated level, peak 430km/s. Density was average or below average. Total IMF, Bt, was predominantly weak, with a few peaks at 9 nT. The north-south component, Bz, alternated between short periods of negative (southward) and positive (northward) but was also weak, +8/-8 nT. Phi angle was generally negative (towards the Sun), with a couple of brief switches to positive (away from the Sun) early in the period. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 was at background levels. High energy electron flux (greater than 2 MeV) has been at background to moderate levels, with a peak of 564 pfu observed at 10/1550 UTC. The 24-hour integrated electron fluence stayed well below the Active threshold, reaching 6.38e6 integrated pfu at 11/0001 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Moderate, with a continuing daily chance of X-class flares through the forecast period, these most likely from AR3182, AR3181, AR3184 or AR3186
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Solar Wind / Geomagnetic Activity: The M2 flare on 9th Jan from AR3181 in the southwest generated a CME, which could give a glancing blow at Earth later on day 2 (12th Jan), although this is a low probability. No other Earth-directed CMEs are in the forecast.

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Solar wind speeds are at slightly-elevated levels, perhaps as a result of weak connection with CH62/-. Geomagnetic activity is expected to be Quiet to Unsettled with a slight chance of isolated Active intervals at first. During day 2 (12th Jan) there is the low chance of a glancing blow from the aforementioned 9th Jan CME, which may increase geomagnetic activity, potentially lasting into day 3 (13th Jan), however this is low confidence. Otherwise, geomagnetic activity should remain at generally Quiet levels.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at background levels throughout. However, there is a risk of an increase should any significant flares occur, giving a slight chance of exceeding the S1/Minor Storm threshold. Electron fluence is likely to remain below the Active (1e8 integrated pfu) threshold, but a limited rise is possible depending on extent of coronal hole influence.

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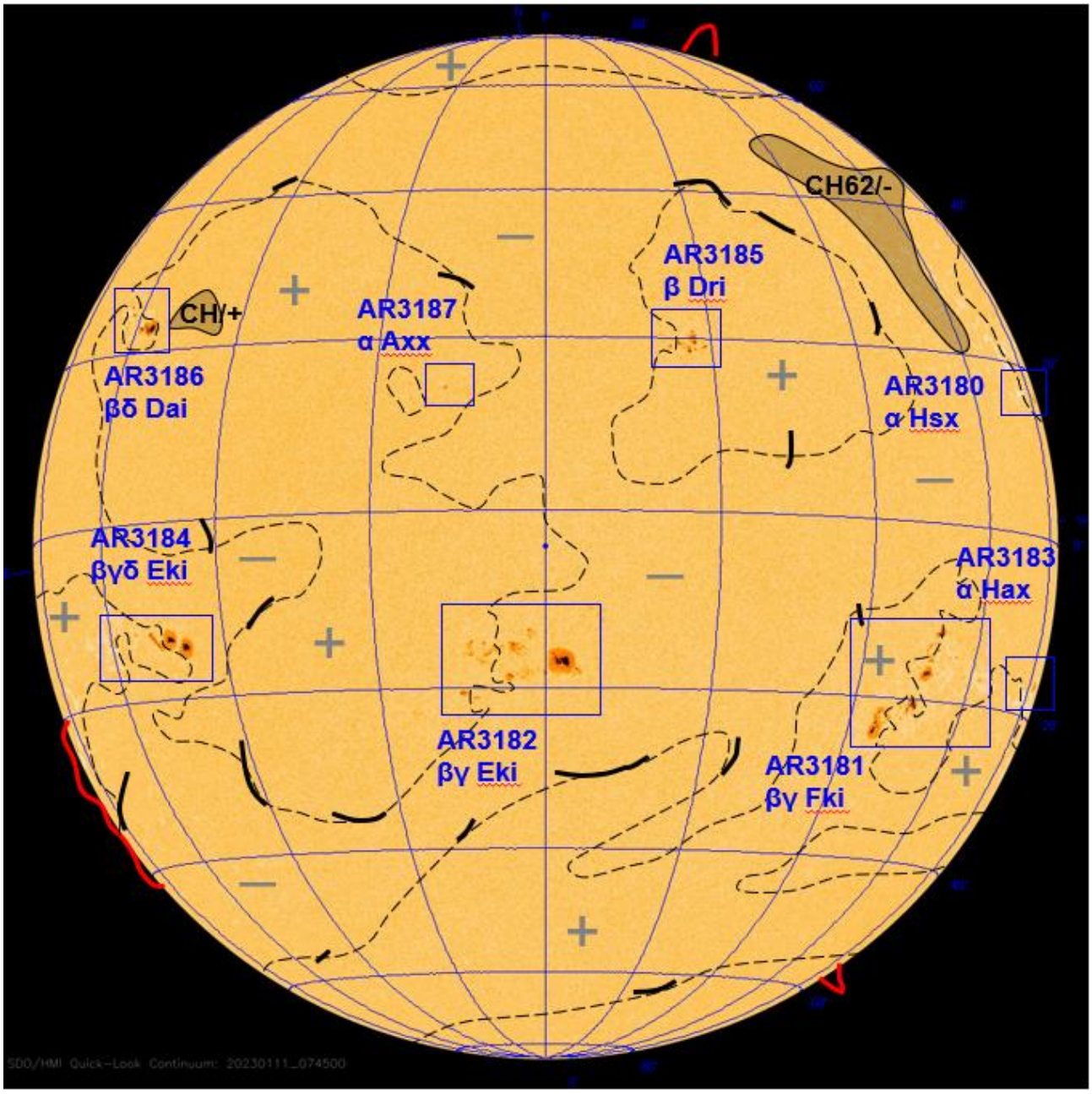
Figure 1. Solar Analysis Valid 11/0800 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

AR3181 in the southwest produced an M2 flare, observed at 09/0901 UTC, which produced a CME. This has been analysed and may give a glancing blow at Earth later on Day 2 (12 Jan), although this is low confidence. No other Earth-directed CMEs are currently expected in the forecast.

Solar wind speeds are at slightly-elevated levels, perhaps as a result of weak connection with CH62/-. Geomagnetic activity is expected to be Quiet to Unsettled with a slight chance of isolated Active intervals at first. During day 2 (12th Jan) there is the low chance of a glancing blow from the aforementioned 9th Jan CME, which may increase geomagnetic activity, potentially lasting into day 3 (13th Jan), however this is low confidence. Otherwise, geomagnetic activity should remain at generally Quiet levels.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/1908	Partial	AR3181	S30W31	445	12/2100	Low probability/low confidence of glancing blow

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Radio Blackouts - X-Ray Flares:

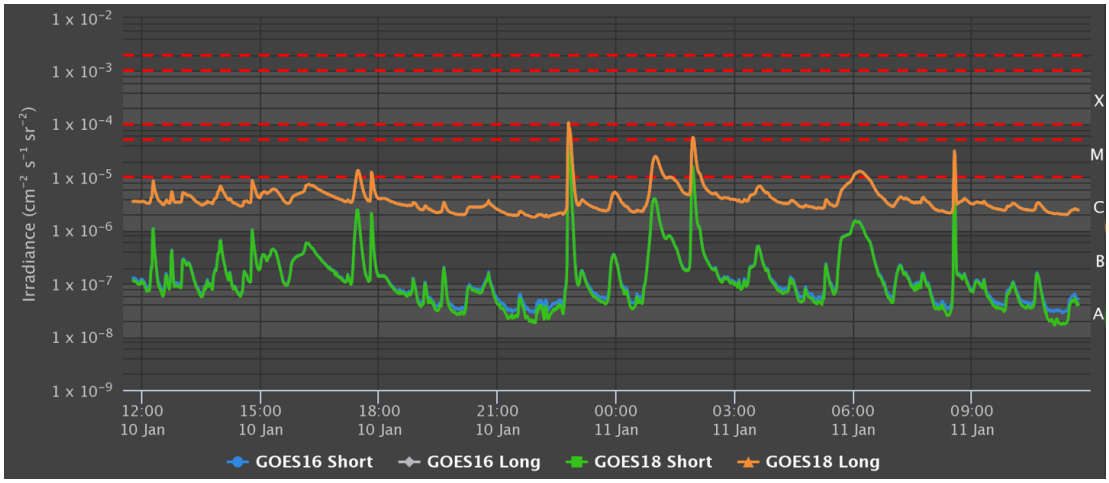
Solar activity has been High in the past 24 hours, An X1 flare from AR3186 was observed at 10/2247UTC. Several M-class flares were also observed, the largest an M5.6 flare at 11/0156UTC from AR3184, in the southeast.

There are currently eight numbered sunspot regions on the visible disc. AR3182 in the southeast quadrant and AR3181 in the southwest remain the largest regions. Both of these regions continue to show slight overall decay. AR3184 located in the far SE quadrant has developed some minor trailing spots, with a Delta configuration now apparent in its intermediate portion. AR3186 in the far northeast continues to grow and develop, with a Delta configuration now apparent in its lead spot. AR3185 has developed further trailing spots. AR3180 and AR3183 appear little changed and relatively stable as they near the west limb. AR3187 has decayed to a single small spot.

Far side seismographs are also indicating plenty of additional potential activity on the far side, and there are signs on SDO imagery of another large active region appearing on the southeast limb with flux looping evident and some magnetic structure on magnetogram products.
Solar activity is expected to be Moderate with a chance of further X-class flares. AR3182, AR3181, AR3184 or AR3186 are the most likely regions to produce further significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	90	90
Very Active	R3 to R5 X Class	Yes	25	25	25	25

Figure 2: GOES16/18 X-ray flux showing flare activity in the past 24 hours.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 has been at background levels. However, any significant flares will bring a risk of proton flux rising, with a slight chance of exceeding the S1/Minor Storm threshold. This is mainly due to the risk presented by both AR3182 and AR3181 as they are now rotating further westwards across the disc, towards a position where they are more likely to connect with Earth for proton storm events. AR3184 will also bear watching in the coming days, depending on how it appears and potentially develops as it rotates more fully across the visible solar disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at background to moderate levels. Any rise in activity is expected to be modest, perhaps reaching Moderate levels at the diurnal peaks. Any glancing blow from a CME later on day 2 (12 Jan) could also keep electron flux levels suppressed.

Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold through the period. Confidence in fluence remaining below Active through most of the period is high, but lower for the likelihood and timing of any possible increase due to the extent of any coronal hole influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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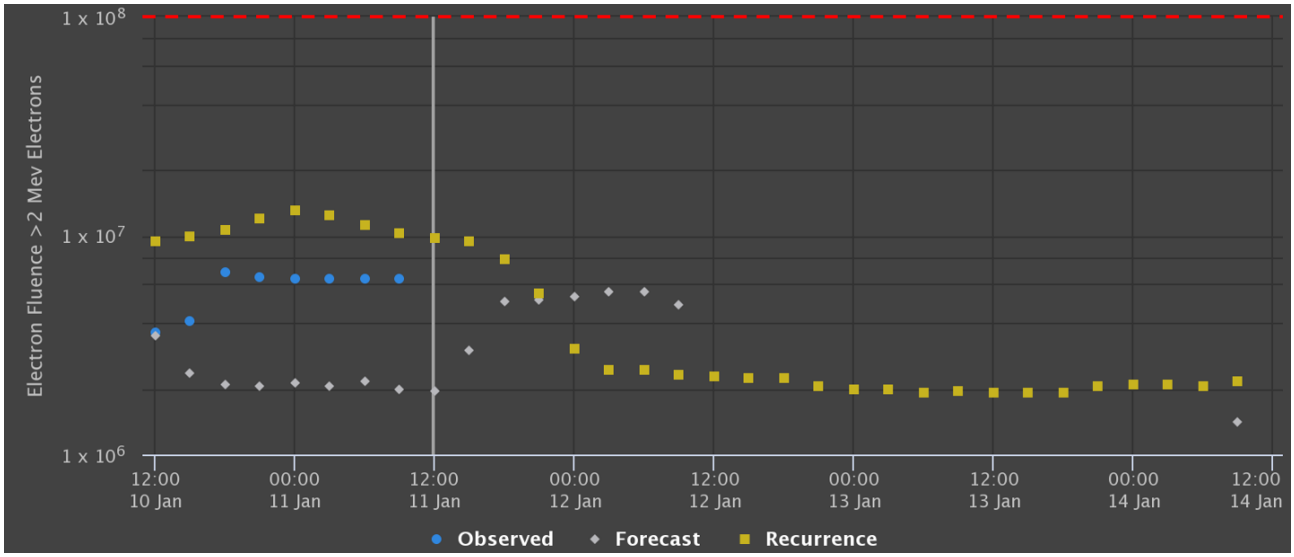
Figure 3: MOSWOC REFM latest.



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